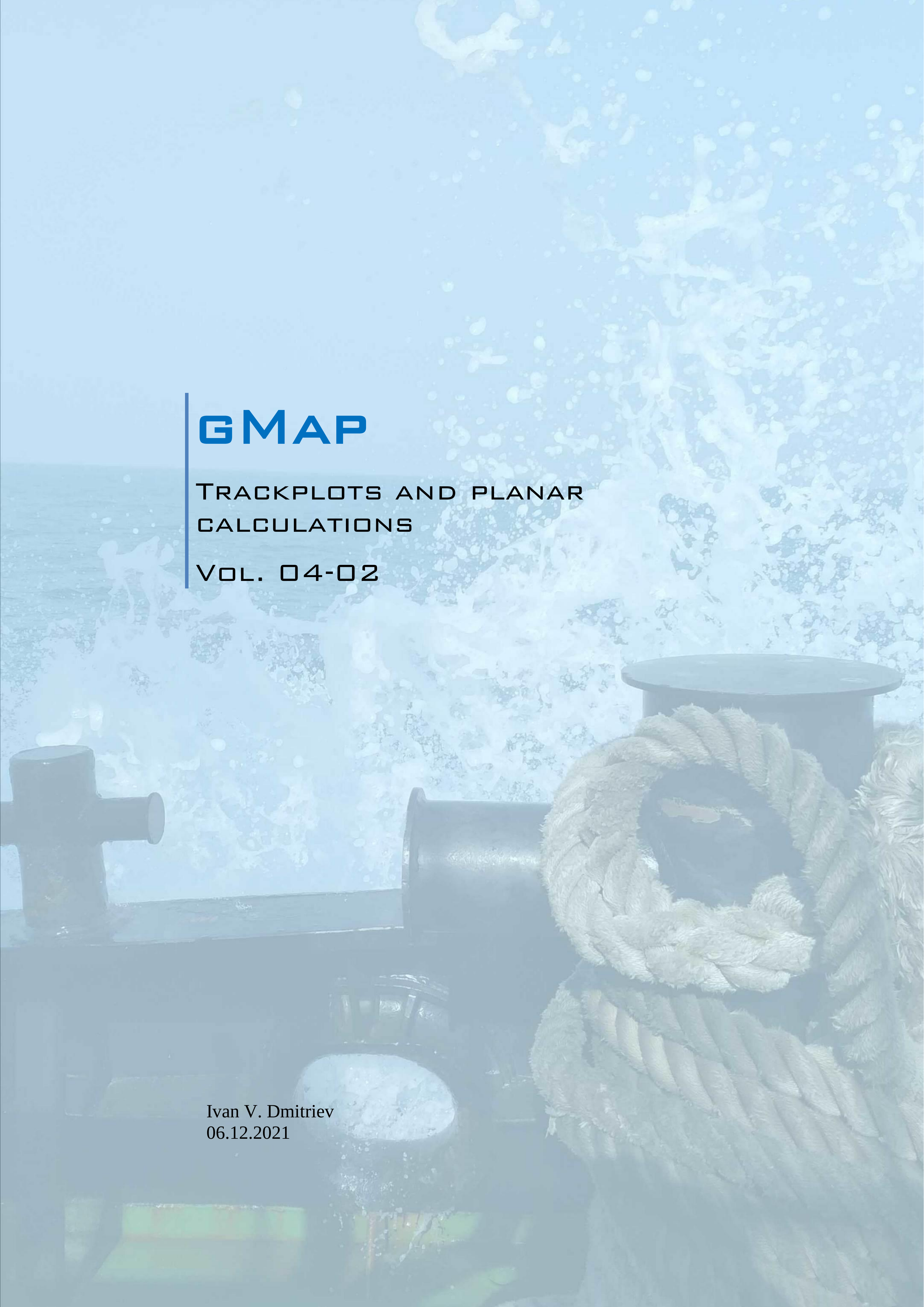

gMap

Trackplots and planar calculations

Vol. 04-02

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MatLab functions set for simple geometric tasks decision (for example, find cross-point for pipeline and survey line), track-plots drawing (MatLab or AutoCAD scripts) and spikes manual removing. The part of functions was adapted to manipulations with Row-content data; the "Track-polyline structure functions" are depends from structure's fields names. The set's functions are shown in ***Table 1.1***.

Table 1.1 gMap functions

Function name	Function description
Geometrics tasks decision: minimal distance, cross, normal	
gMapGeomPoints2DMinDist	Minimal distance for two 2D-polylines
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1.1 Track-polyline structure types

The Track-polyline structure usually is used as 2D-on-plane polyline container. Track-polyline is on-plane polyline structure, which used as "interface structure" for track-plots, line-planning and other "planar objects" drawing and exports to AutoCad. There are Track-polyline structure fields in ***Table 1.2***. Usually Track-polyline is not containing GpsDay and GpsTime fields, but it can be include for compatibility with DTEN-fields functions.

There are follow Track-polyline types: LinePlan, LinePlanKP, PipeLineTrack, Track.

Table 1.2 Track-polyline structure fields' names

Field name	Field Description
PLName	Track-polyline name.
Type	Track-polyline types: Trackplot, LinePlan, PipeLineTrack, etc.
KeyLineDraw	String key for polyline drawing in MatLab figure (for example: '-r','xb').
GpsE	Polyline's points rectangular projection Easting.
GpsN	Polyline's points rectangular projection Northing.

Field name	Field Description
GpsH	Optional field. Polyline's points height created when Ellipsoid-to-Ellipsoid coordinates transformation take place; field used for coordinates transformation's stability.
GpsZ	Optional field. Polyline's points Z-axis coordinate for vertical geodetic datum (pipeline or towing equipment position).
GpsKP	Optional field, polyline KP. This field has different meaning for polyline types: PipeLineTrack – pipeline KP; Trackplot – measurement/ping/shot number.
GpsDay	Optional field. Used as part of DTEN-fields.
GpsTime	Optional field. Used as part of DTEN-fields.
PipeD	Optional field. Pipeline diameter.
WaterDepth	Optional field. Water Depth for current points coordinates (can be "actual" or referenced to some system MLS, LAT, Baltic, etc).

LinePlan (Track-polyline type)

There are used follow field names: PLName, Type='LinePlan', KeyLineDraw, GpsE, GpsN. The LinePlan used for on-plane objects drawing only (gMapPLDraw function) and for objects export to AutoCAD (gMapPL2AcadExport function); there are:

-- Line planning net;

-- Survey zone area;

-- Pipelines (drawing only);

-- Platforms and another infrastructure object's borders, which draw with polyline;

-- Targets like ADCP, wells and another one-point-targets (the polyline contained only one point).

The LinePlan file format in txt included LineName, E/Lat, N/Lon data:

LineName1, E1, N1, ..., En, Nn

....

LineNameN, E1, N1, ..., En, Nn

One polyline is one row. The delimiters are: ',' '\t' ';'.

LinePlanKP (Track-polyline type)

There are used follow field names: PLName, Type='LinePlanKP', KeyLineDraw, GpsE, GpsN, GpsKP. The LinePlan used for on-plane objects drawing (gMapPLDraw function) and for objects export to AutoCAD (gMapPL2AcadExport function). The GpsKP-field allows to drawn GpsKP numbers near polyline points and calculates KP for cross-points (for example, for pipeline and survey line).

The GpsKP-field can contain not only Kilometer Points; it can be Shot Number or Measurements Number for Survey line. The LinePlanKP type can use for:

-- Pipelines with Kilometer Points;

-- Survey Lines track-plots with Measurements Number;

-- Line planning net with KP marks (for example, High Resolution seismic).

The LinePlan file format in txt included LineName, E/Lat, N/Lon, KP data:

LineName1, E1, N1, KP1, ..., En, Nn, KPn

....

LineNameN, E1, N1, KP1, ..., En, Nn, KPn

One polyline-with-KP is one row. The delimiters are: ',' '\t' ';'.

PipeLineTrack (Track-polyline type)

There are used follow field names: PLName, Type='PipeLineTrack', KeyLineDraw, GpsE, GpsN. The optional fields are: GpsKP, GpsZ, PipeD. The PipeLineTrack-type was created for pipe-line drawing and some calculations (for example: cross-point for pipeline and survey line; diffraction point hyperbola from pipeline for SBP-data). The optional fields can be presented or not presented; in the second case the fields' names are equal to LinePlan-type.

The LinePlan file format in txt included LineName, E/Lat, N/Lon, KP, Z, PipeD data:

E, N, KP, Z, PipeD

....

En, Nn, KPn, Zn, PipeDn

One polyline is presented as single file which includes from 2 to 5 columns. The delimiters are: ',' '\t' ';'.

Track (Track-polyline type)

There are used follow field names: PLName, Type='Track', KeyLineDraw, GpsE, GpsN, GpsDay, GpsTime. The optional fields are: GpsH, GpsKP, GpsZ. The Track-type was created for Equipment's track-plot drawing and some calculations. The Track-type contains DTEN-fields (see below) for track-plot coordinates transformation from datum to datum.

The Track file format in txt included follow data:

YYYY1 MM1 DD1 hh1 mm1 ss.sss1 E1 N1 H1 KP1 Z1 WaterDepth

....

YYYYn MMn DDn hhn mmn ss.sssn En Nn Hn KPn Zn WaterDepth

Where: YYYY – year, MM – month, DD – day, hh – hour, mm – minute, ss.sss – second; it will converted to GpsDay, GpsTime fields.

One polyline is presented as single file which includes from 8 to 11 columns. The delimiters are: ',' '\t' ';'.

1.2 DTEN-fields

GpsKP, GpsDay, GpsTime, GpsE, GpsN, GpsH are named the DTEN-fields, it is define measurement time and coordinates in planar projection. The fields are used for "universalized" time/coordinates fields for different structures, for example sgy-structure, xtf-structure, jsf-structure (the functions were used gSgyDTEN, gSgyDTENinv, gXtfDTEN, gJsfDTEN).

2. Geometrics tasks decision: minimal distance, cross, normal

There are some geometrics trivial tasks decisions:

- minimal distance from point to polyline/points_set;
- cross points calculation for segments;
- distance from point to segments/lines by normal.

Axis direction: y- up, x- right; rotation: from x, left is +.

0) Lines equations were used

Line general equation is

$$Ax + By + C = 0$$

Parametric equation is

$$\frac{A}{-C}x + \frac{B}{-C}y = 1;$$

1) Across two points Line's equation

$$\begin{vmatrix} x & y & 1 \\ x1 & y1 & 1 \\ x2 & y2 & 1 \end{vmatrix} = 0;$$

$$(y1 - y2) \cdot x + (x2 - x1) \cdot y + (x1y2 - y1x2) = 0;$$

$$A = y1 - y2; B = x2 - x1; C = x1y2 - y1x2;$$

General line's equation A1x+A2y+A3=0, for points a1 and a2 code is

```
>> len=size(xy1,2); %xy1 and xy2 are rows with first and second points' coordinates
>> ABC=cross([xy1(1,:);xy1(2,:);ones(1,len)],[xy2(1,:);xy2(2,:);ones(1,len)],1);
```

2) Cross lines point equation

$$\begin{vmatrix} A & B & C \\ A1 & B1 & C1 \\ A2 & B2 & C2 \end{vmatrix} = 0;$$

$$A \cdot (B1C2 - C1B2) + B \cdot (C1A2 - A1C2) + C \cdot (A1B2 - B1A2) = 0;$$

Point coordinates are

$$A \cdot \frac{B1C2 - C1B2}{A1B2 - B1A2} + B \cdot \frac{C1A2 - A1C2}{A1B2 - B1A2} + C = 0;$$

$$x = \frac{B1C2 - C1B2}{A1B2 - B1A2}; y = \frac{C1A2 - A1C2}{A1B2 - B1A2};$$

Cross points (x,y) for A1x+B1y+C1=0 and A2x+B2y+C2=0 lines code is

```
>> % ABC1 and ABC2 are rows with crossed lines coefficients;
>> k=cross(ABC1,ABC2,1); xy=[k(1,:)./k(3,:);k(2,:)./k(3,:)];
```

If lines are collinear, then c=[0 0 0];d=[nan nan].

2.1 Minimal distance for two 2D-polylines

function [nk2,nK2,Dmin]=gMapGeomPoints2DMinDist(kxy,dk,KXY,dK,key_one)

Find minimal distance from each kxy-points to all KXY-points (2D only). If key_one parameter set to one, than least distance from all kxy-points to all KXY-points be founded (for example for polyline “cross-point” search).

The kp-column for kxy and KXY can be used as numbers/ID for points. We can consider points as consecutive points of polyline, and kp-column as “distance” between points; using dk and dK parameters we can add additional points (linear interpolation) between existing for more careful distance search.

Parameters:

kxy – rows [kp;x;y] with points_1 (polyline_1) coordinates;

dk – kp-step for points_1 (polyline_1) point to point; if isrmpty, than kp is not recalc;

KXY – rows [KP;X;Y] with points_2 or polyline_2 coordinates;

dK – KP-step for polyline_2 point to point; if isrmpty, than kp is not recalc;

key_one – if key==1 then the least distance from all kxy-points to all KXY-points be founded.

nk2 – points_1 [numbers;X;Y] or polyline_1 [kp;X;Y] for minimal distance search;

nK2 – points_2 [numbers;X;Y] or polyline_2 [KP;X;Y] for minimal distance with k2(n) was founded;

Dmin – minimal distance value between k2 and nK2;

Example 1.

```
>> [k2,nK2,Dmin]=gMapGeomPoints2DMinDist(kxy,[],KXY,[],0);
>> [k2,nK2,Dmin]=gMapGeomPoints2DMinDist(kxy,0.1,KXY,0.1,0);
```

Example 2 (***Figure 2.1***). Pipelines KP and coordinates read to ‘a’; SBP pings numbers and coordinates read to ‘xy’. Calculate nearest point’s values.

```
>> a=dlmread('e:\01_Surveys\2015_KpXY_final.txt'); %a=[KP X Y];
>> JsfHead=gJsfHeaderRead ('e:\ROMONA\16_04.000a_CV.jsf',0);
>> [Head,Data]=gJsf0080Read(JsfHead,0,0); xy=[1:length(Head.X);Head.X./100;Head.Y./100]';
>> [nk2,nK2,Dmin]=gMapGeomPoints2DMinDist(xy',[],a(:,1:3)',[],1);
>> figure(1); plot(xy(:,2),xy(:,3),'.r'); hold on; plot(a(:,2),a(:,3),'ob'); plot(xy(nk2(1)-
xy(1,1)+1,2),xy(nk2(1)- xy(1,1)+1,3),'xr'); hold on; plot(a(nK2(1)-a(1,1)+1,2),a(nK2(1)-a(1,1)+1,3),'xb');
hold off;
```

Example 3 (***Figure 2.2***). Pipelines KP and coordinates read to ‘a’; SBP pings numbers and coordinates read to ‘xy’. Calculate nearest point’s values; using smaller step (additional points).

```
>> a=dlmread('e:\01_Surveys\2015_KpXY_final.txt'); %a=[KP X Y];
>> JsfHead=gJsfHeaderRead ('e:\16_04.000a_CV.jsf',0);
>> [Head,Data]=gJsf0080Read (JsfHead,0,0); xy=[1:length(Head.X);Head.X./100;Head.Y./100]';
>> [nk2,nK2,Dmin]=gMapGeomPoints2DMinDist(xy',0.5,a(:,1:3)',0.1,1);
>> figure(1); plot(xy(:,2),xy(:,3),'.r'); hold on; plot(a(:,2),a(:,3),'ob'); plot(nk2(2),nk2(3),'xr');hold on;
plot(nK2(2),nK2(3),'xb'); hold off;
```

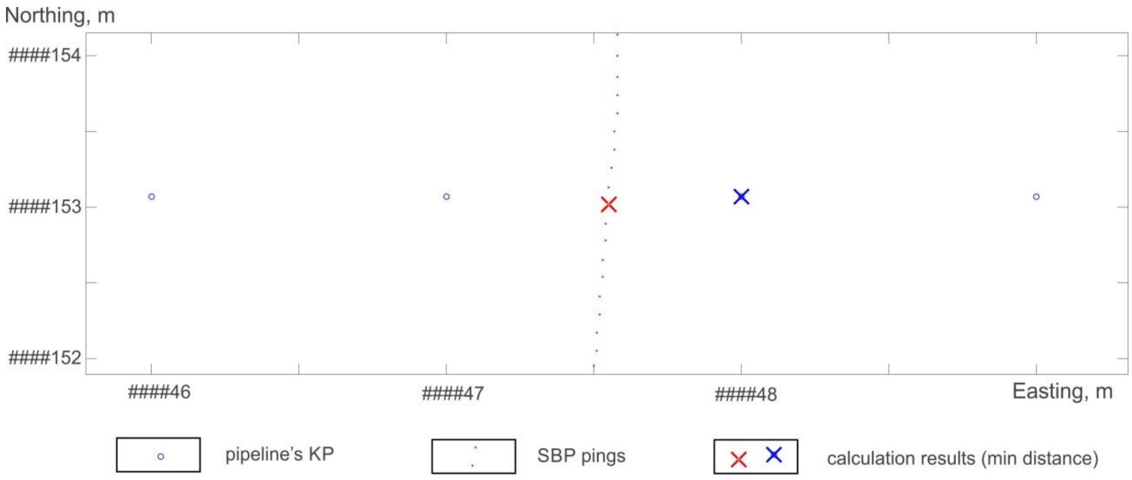


Figure 2.1 gMapGeomPoints2DMinDist using example

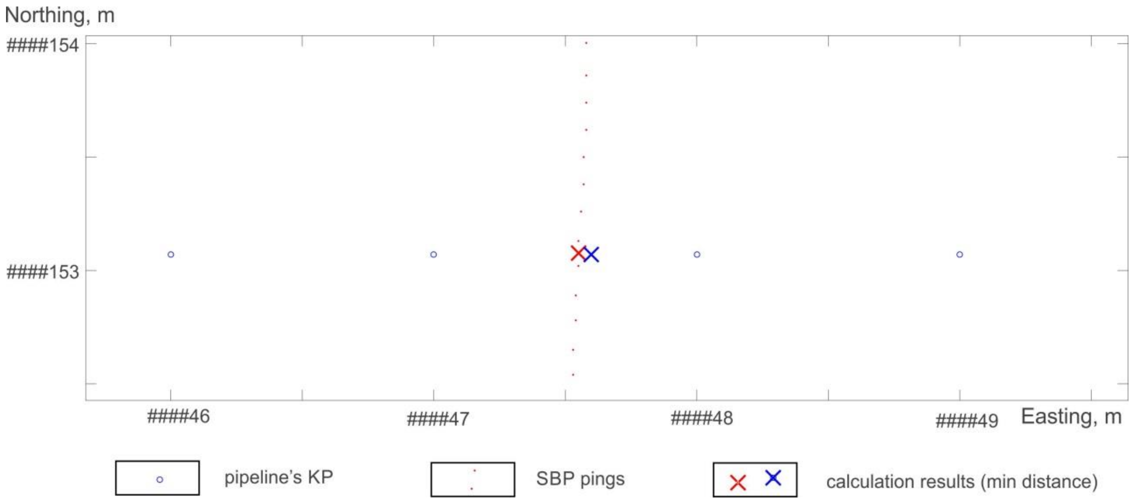


Figure 2.2 gMapGeomPoints2DMinDist with additional KP using example

2.2 Cross points for segments pairs

function [d,mask]=gMapGeomSegments2DCross(a1,a2,b1,b2)

Find cross points for segments pairs a1_to_a2 and b1_to_b2 (2D only); cross point coordinates is nan, if segments in pair are parallel. The a1 and a2 are first and last a-segment's points; b1 and b2 are first and last b-segment's points. The number of a and b segments must be equal; if only one a-segment was define for several b-segments, than a-segment will be replicate to b-segments number.

Parameters:

a1 – rows with a1(x,y) points coordinates for segments a1_to_a2;

a2 – rows with a2(x,y) points coordinates for segments a1_to_a2;

b1 – rows with b1(x,y) points coordinates for segments b1_to_b2;

b2 – rows with b2(x,y) points coordinates for segments b1_to_b2;

d – rows with cross point (x,y) for lines, created on a1_to_a2 and b1_to_b2;

mask – row mask for "cross point in borders of segments a1_to_a2 and b1_to_b2";

Example 1.

```
>> [d,mask]=gMapGeomSegments2DCross([0 0;0 0;0 0]',[10 10;10 10;10 10]',[-8 9;-3 5;6 -1]',[-3 5;6 -1;10 -2]');
>> [d,mask]=gMapGeomSegments2DCross([1 1]',[10 10]',[-8 9;-3 5;6 -1]',[-3 5;6 -1;10 -2]');
```

Example 2 (*Figure 2.3*). Pipelines KP and coordinates read to 'a'; SBP pings numbers and coordinates read to 'xy'. Calculate cross-point.

```
>> a=dlmread('e:\01_Surveys\2015_KpXY_final.txt'); %a=[KP X Y];
>> JsfHead=gJsfHeaderRead ('e:\16_04.000a_CV.jsf',0);
>> [Head,Data]=gJsf0080Read(JsfHead,0,0); xy=[1:length(Head.X);Head.X./100;Head.Y./100]';
>> [nk2,nK2,Dmin]=gMapGeomPoints2DMinDist(xy',[],a(:,1:3)',[],1);
>> figure(1); plot(xy(:,2),xy(:,3),'.r'); hold on; plot(a(:,2),a(:,3),'ob'); plot(xy(nk2(1)-xy(1,1)+1,2),xy(nk2(1)-xy(1,1)+1,3),'xr'); hold on; plot(a(nK2(1)-a(1,1)+1,2),a(nK2(1)-a(1,1)+1,3),'xb'); hold off;
>> [d,mask]=gMapGeomSegments2DCross(a(nK2(1)-a(1,1),2:3)',a(nK2(1)-a(1,1)+1,2:3)',xy(1:end-1,2:3)',xy(2:end,2:3)');
>> plot(d(1,find(mask)),d(2,find(mask)),'x');
```

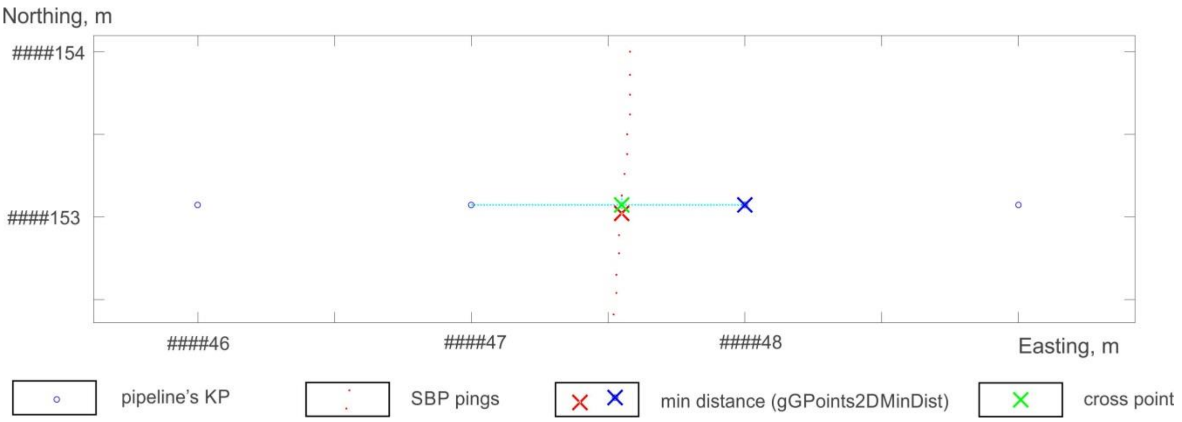


Figure 2.3 gMapGeomSegments2DCross using example

2.3 Normal from points to segments

function [d,r,mask]=gMapGeomPointsSegments2DNormal(a1,b1,b2)

Find cross points for pairs normal from points a1 and segments b1_to_b2 (2D only). The number of a1 points and b segments must be equal; if only one a1-point was define for several b-segments, than a1-point will be replicate to b-segments number. Functions works correctly if point on line formed on b1_to_b2 segment.

Parameters:

a1 – rows with a1(x,y) points coordinates;

b1 – rows with b1(x,y) points coordinates for segments b1_to_b2;

b2 – rows with b2(x,y) points coordinates for segments b1_to_b2;

d – rows with cross point coordinates (x,y) for normal from a1 to line formed on b1_to_b2;

r – row "signed" distance from a1 to cross point (x,y);if we go from fist to second Kp then left side "sign" is negativ.

mask – mask for "cross point in borders of b1_to_b2 segment".

Example 1.

```
>> [d,r,mask]=gMapGeomPointsSegments2DNormal([0 0;0 0;0 0]’,[-8 9;-3 5;6 -1]’,[-3 5;6 -1;10 -2]’);
>> [d,r,mask]=gMapGeomPointsSegments2DNormal([1 1]’,[-8 9;-3 5;6 -1]’,[-3 5;6 -1;10 -2]’);
```

Example 2 (*Figure 2.4*). Pipelines KP and coordinates read to ‘a’; SBP pings numbers and coordinates read to ‘xy’. Calculate normal from pipelines KP to SBP-trackplot-segments.

```
>> a=dlmread('e:\01_Surveys\2015_KpXY_final.txt'); %a=[KP X Y];
>> JsfHead=gJsfHeaderRead ('e:\16_04.000a_CV.jsf',0);
>> [Head,Data]=gJsf0080Read (JsfHead,0,0); xy=[1:length(Head.X);Head.X./100;Head.Y./100]';
>> [nk2,nK2,Dmin]=gMapGeomPoints2DMinDist(xy',[],a(:,1:3)',[],1);
>> figure(1); plot(xy(:,2),xy(:,3),'.r'); hold on; plot(a(:,2),a(:,3),'ob'); plot(xy(nk2(1)-
xy(1,1)+1,2),xy(nk2(1)-xy(1,1)+1,3),'xr'); hold on; plot(a(nK2(1)-a(1,1)+1,2),a(nK2(1)-a(1,1)+1,3),'xb');
>> [d,r,mask]=gMapGeomPointsSegments2DNormal(a(nK2(1)-a(1,1)+1,2:3)',xy(1:end-
1,2:3)',xy(2:end,2:3)');
>> plot(d(1,find(mask)),d(2,find(mask)),'xg');
```

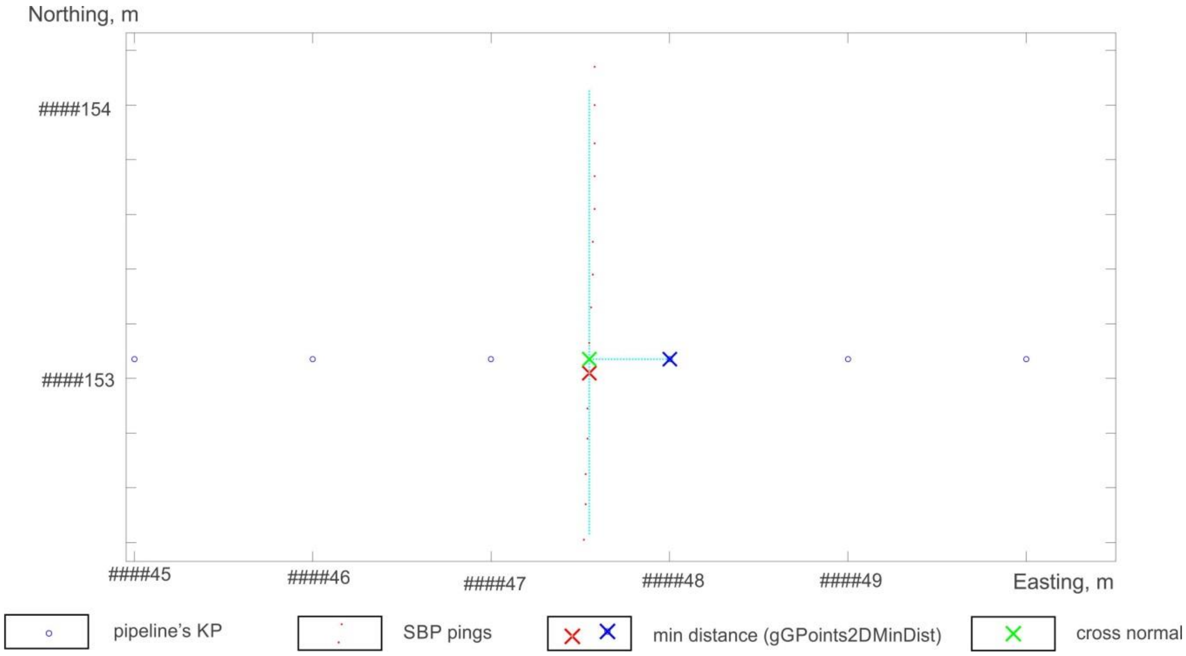


Figure 2.4 gGPointsSegments2DNormal using example

Example 3 (*Figure 2.5*)

```
>> [d,r,mask]=gMapGeomPointsSegments2DNormal([1;1],[0;3],[5;0]);
ans: d = [1.617647058823529; 2.029411764705882]; r = 1.200490095997562; mask = 1
```

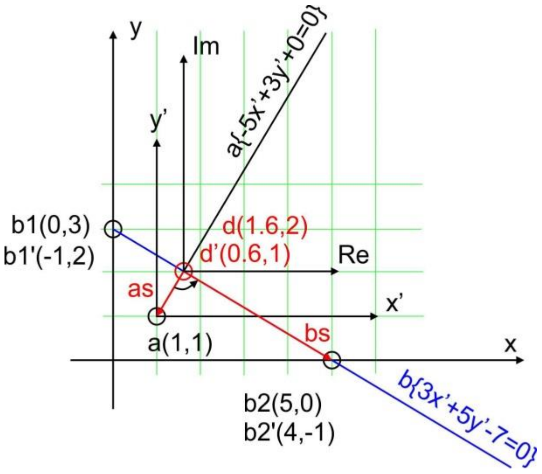


Figure 2.5 gMapGeomPointsSegments2DNormal using example chart

2.4 Minimal-distance-normal from points to polyline

function [dd,rrr]=gMapGeomPointsPolyline2DNormal(a,b)

Find cross points for normal from points a to polyline b (2D only).

Parameters:

a – rows with a(x,y) points coordinates;

b – rows with b(kp,x,y) points coordinates for polyline;

dd – rows with cross point coordinates (x,y) for normal from points to polyline;

r – row "signed" distance from points to cross points (x,y);if we go from fist to second kp then left side "sign" is negativ.

Algorithm: 1) find min distance from point to polyline points, 2) try to draw normal for two segments near minimal-distance-point.

Example.

```
>> [dd,r]=gMapGeomPointsPolyline2DNormal([1;1],[1 2 3;-5 -1 7;8 -3 -6]);
>> a=dlmread('d:\pointsXY.txt')';b=dlmread('e:\KpXY.txt')';
>> [dd,r]=gMapGeomPointsPolyline2DNormal(a,b);
>> plot(b(2,:),b(3,:),'.-');hold on;plot(a(1,:),a(2,:),'o');plot(dd(2,:),dd(3,:),'x');axis equal;
```

2.5 Linear approximation for polyline

function [a,b,stdxy,mask]=gMapGeomLineDirect2D(X,Y,rk)

Linear approximation for polyline; robust calculation a,b for y=ax+b. Used for Survey line direction calculation.

Parameters:

X – vector x;

Y – vector y;

rk – vector std-coefficients for robust procedure, usually [3 2.5];

a,b – calculated a and b;

stdxy – standard deviation for Y-ax+b;

mask – logical mask for elements y and x, which take part in a,b calculation.

Example:

```
>> [a,b,stdxy,mask]=gMapGeomLineDirect2D([1 3 2 5 7 9 3 1],[7 15 90 23 31 39 15 7],[3 2.5 2]);
```

3. Track-polyline structure functions

3.1 Read Track-polyline from txt-file

function PL=gMapPLReadTxt(fName,keyRead,KeyLineDraw)

Read data from txt-file to Track-polyline structure (2D-on-plane polyline).

Parameters:

fName – file name for reading;

keyRead – key for reading: 1) LinePlan format; 2) PipeLineTrack format; 3) LinePlanKP file format; 4) Track in DTEN format;

if keyRead(1)==2, than keyRead(2..5) is columns numbers for [E N KP Z PipeD], set NaN if data not exist for GpsKP or GpsZ

if keyRead(1)==4, than keyRead(2..12) is [YYYY MM DD HH MM SS.SSS E N H KP Z], set NaN if data not exist for GpsH or GpsKP or GpsZ

keyLineDraw – string key for line drawing: '-r','xb', etc;

PL – output structure: PL(n).PLName, PL(n).Type, PL(n).KeyLineDraw, PL(n).GpsE, PL(n).GpsN; Extended fields are: PL(n).GpsH, PL(n).GpsKP, PL(n).GpsDay, PL(n).GpsTime, PL(n).PipeD. Function Example:

```
>> PL=gMapPLReadTxt('c:\temp\SSS\V3LinePlan.txt',1,'-c');gMapPLDraw(100,PL);axis equal;
>> PL=gMapPLReadTxt('c:\temp\SSS\V3LinePlan.txt',[2 1 2 5 nan nan],'-c');
```

1--LinePlan file format

There are rows included LineName and E/Lat, N/Lon coordinates:

LineName1, E1, N1, ..., En, Nn

....

LineNameN, E1, N1, ..., En, Nn

The delimiters are: ',' '\t' ';'.

2--PipeLineTrack file format

There are a number of columns included E, N, KP(?), Z(?); columns positions are defined in keyRead:

E, N, KP, Z, PipeD

....

En, Nn, KPn, Zn, PipeDn

The delimiters are: ',' '\t' ';'.

3--LinePlanKP file format

There are rows included E, N, KP:

LineName1, E1, N1, KP1, ..., En, Nn, KPn

....

LineNameN, E1, N1, KP1, ..., En, Nn, KPn

The delimiters are: ',' '\t' ';'.

4--Track in DTEN format

There are a number of columns included Date, Time, E, N, H(?), KP(?), Z(?), WaterDepth(?):

YYYY1 MM1 DD1 hh1 mm1 ss.sss1 E1 N1 H1 KP1 Z1 WaterDepth

....

YYYYn MMn DDn hhn mmn ss.sssn En Nn Hn KPn Zn WaterDepth

3.2 Write Track-polyline to txt-file

function gMapPLWriteTxt(fName,PL,keyWrite)

Export Track-polyline structure to txt-file.

Parameters:

fName – file or folder name for export;

PL – polyline structure: PL(n).PLName; PL(n).Type; PL(n).KeyLineDraw; PL(n).GpsE; PL(n).GpsN; PL(n).GpsKP

keyWrite(1) – Track-polyline type code.

if keyWrite(1)=1 >> 'LinePlan', than all lines write to single file with name "fName", in "LinePlan file format";

if keyWrite(1)=2 >> 'PipeLineTrack', than each line write to oun file with names "PL(n).PLName" at folder "fName", in "PipeLineTrack" file format;

if keyWrite(1)=3 >> 'LinePlanKP', than all lines write to single file with name "fName", in "LinePlanKP file format".

keyWrite(2) – digits number for numbers in file.

Function Example:

```
>> gMapPLWriteTxt('c:\temp\PL1.txt',PL,[1 3]);
```

3.3 Draw Track-polyline

function gMapPLDraw(figDraw,PL,flText)

Draw poly lines from Track-polyline structure.

Parameters:

f – figure number or handle;

PL – track-polyline structure, field used: PL(n).PLName(?); PL(n).KeyLineDraw(?); PL(n).GpsE; PL(n).GpsN;

Function Example:

```
>> PLLine=gMapPLReadTxt('c:\temp\SSS\V3LinePlan.txt',1,'-c');
```

>> gMapPLDraw(100,PLLine);axis equal;

3.4 Track-polyline export to AutoCAD

function gMapPL2AcadExport (fName,PL,PLNameAttr,CircleAttr,KPNameAttr,DigitNum,PointsStep,flLayers)

Export Track-polyline structure to AutoCad script

Parameters:

fName – file or folder name for export; if fName(end)=='\', then each PL write to file [PL(n).PLName '.scr'];

PL – polyline structure ncludes: PL(n).PLName; PL(n).GpsE; PL(n).GpsN; PL(n).GpsKP(?);

PLNameAttr=[Size Angle dE dN CircleRadius] – PL(n).PLName text attributes;

if PLNameAttr=[Size Angle], than dE=0, dN=0;

if PLNameAttr includes CircleRadius, then draw circle for first polyline's point, using CircleRadius;

CircleAttr=[Radius DrawModulio] – circles draw attributes for polyline's points;

KPNameAttr=[Size Angle DrawModulio KPDigitNum] – PL(n).GpsKP text attributes for polyline's points (combine with circles);

DigitNum – number of digits after floating point for pline/circles;

PointsStep – step of points for polyline draw (gAcadPline);

flLayers – each pline to own layer.

Acad coordinates:

^pY

|

o--->pX

Function Example:

>> PLXtf=gXtf000Dir2PLRead('c:\temp\SSS\3\','-b',[6378137 0.081819190842621],[0 141 0.9996 500000 0],[],1,1);

>> gMapPL2AcadExport('c:\temp\SSS\3\Cad\',PLXtf,[7 0 0 2 3],[5 100],[2 0 500 1],2,1,1);

>> PL=gMapPLReadTxt('e:\Lazarev170818.txt',3,'.');

>> gMapPL2AcadExport('c:\temp\333.scr',PL,[3 0],[0.3 1],[1 0 500 2],2,1,0);

3.5 Calculate [length points_num] for Track-polyline

function Len=gMapPLLength(PL,sm)

Calculate [length points_num] for poly-lines from Track-polyline structure

Parameters:

PL – track-polyline structure, field used: PL(n).GpsE; PL(n).GpsN; PL(n).GpsZ;

sm – smooth value;

LenNum=[length points_num].

Function Example:

>> PL=gMapPLReadTxt('c:\temp\SSS\V3LinePlan.txt',1,'-c');

>> gMapPLDraw(100,PL); axis equal; LenNum=gMapPLLength(PL,10);

3.6 Minimized Z-axis difference for Track-polylines by shift

function [PL,varargout]=gMapPLShiftZaxis(PL,dMax,NumIter,drFl) 17/10/2020

Minimized mean Z-axis difference for Track-polylines set in a cross points. The function shifted PLs, using PL(n).GpsZ=PL(n).GpsZ+difference. Each PL must have one cross-point minimum.

Parameters:

PL – input structure: PL(n).PLName; PL(n).GpsKP; PL(n).GpsE; PL(n).GpsN; PL(n).GpsZ; PL(n).Type; PL(n).KeyLineDraw;

dMax – maximum mean Z-difference between crosses for each PL;

NumIter – maximum number of iteration for PL's shifting;

drFl – flag for draw figure with differences;

AcadFile – file name for Autocad's script (no file will be created if empty);

PL – output structure: PL(n).PLName; PL(n).GpsKP; PL(n).GpsE; PL(n).GpsN; PL(n).GpsZ; PL(n).Type; PL(n).KeyLineDraw;

varargout{1} – dZshift - adds for each PL;

varargout{2}=[dZpl dZstd dZnum dZmad dZrms] – statistical estimations:

dZpl – mean GpsZ-difference between crosses for each PL;

dZstd – standard deviation around dZpl;

dZnum – the number of cross-points;

dZmd – mean absolute for Z-differences (for all PL's crosses);

dZrm – root-mean-square for Z-differences;

varargout{3} – dZnode - max differens value for all crosses;

varargout{4} – Num - crosses-matrix;

varargout{5} – Num2 - balanced crosses-matrix.

Remark: the "nanmean" function for using without Statistical Toolbox was added as a local.

Function Example:

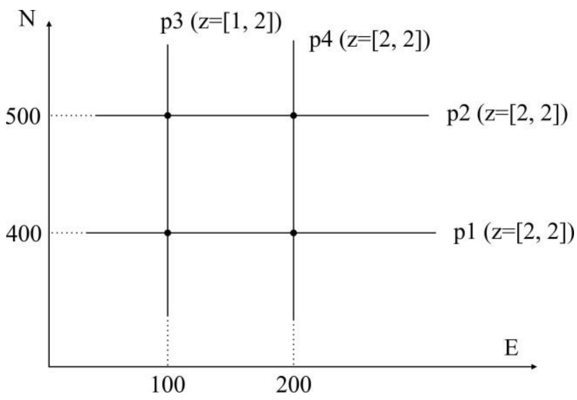
>> [PL2,dZshift,dZpl,dZnode,Num,Num2]=gMapPLShiftZaxis(PL,0.01,500000,1,'c:\temp\zshift');

Function gMapPLShiftZaxis: short algorithm description

0) Set polyline structure:

```
>> PL(1)=struct('PLName','p1','GpsKP',[180 190],'GpsE',[200 100],'GpsN',[400 400],'GpsZ',[2 2]);
>> PL(2)=struct('PLName','p1','GpsKP',[280 290],'GpsE',[200 100],'GpsN',[500 500],'GpsZ',[2 2]);
>> PL(3)=struct('PLName','p1','GpsKP',[380 390],'GpsE',[100 100],'GpsN',[500 400],'GpsZ',[1 2]);
>> PL(4)=struct('PLName','p1','GpsKP',[480 490],'GpsE',[200 200],'GpsN',[500 400],'GpsZ',[2 2]);
>> [PL,v]=gMapPLShiftZaxis(PL,0.01,10,1,'c:\temp\qzz.txt');
```

The figure of crossed lines



Start calculations

>> [PL2,dZshift,dZpl,dZnode,Num,Num2]=gMapPLShiftZaxis(PL,0.01,500000,1,'c:\tmp\qzz.t');

1) The cross-points between each line to all other lines are finding.

2) Using cross-points the algorithm formed Num – 4 “layers” matrix.

Num(1) >> contained point number for PL-row which crossed with PL-column.

	PL1	PL2	PL3	PL4
PL1	NaN	NaN	2	1
PL2	NaN	NaN	2	1
PL3	2	1	NaN	NaN
PL4	2	1	NaN	NaN

Num(2) >> contained Z for point number for PL-row which crossed with PL-column.

	PL1	PL2	PL3	PL4
PL1	NaN	NaN	2	2
PL2	NaN	NaN	2	2
PL3	2	1	NaN	NaN
PL4	2	2	NaN	NaN

Num(3) >> contained point number for PL-column which crossed with PL-row.

	PL1	PL2	PL3	PL4
PL1	NaN	NaN	2	2
PL2	NaN	NaN	1	1
PL3	2	2	NaN	NaN
PL4	1	1	NaN	NaN

Num(4) >> contained Z for point number for PL-column which crossed with PL-row.

	PL1	PL2	PL3	PL4
PL1	NaN	NaN	2	2
PL2	NaN	NaN	1	2
PL3	2	2	NaN	NaN
PL4	2	2	NaN	NaN

3) The calculate difference between Z for cross-points.

Num(2) – Num(4) >> difference between Z for PL-row and Z for PL-column.

	PL1	PL2	PL3	PL4
PL1	NaN	NaN	0	0
PL2	NaN	NaN	1	0
PL3	0	-1	NaN	NaN
PL4	0	0	NaN	NaN

4) Calculate the mean for columns with difference.

dZpl >> mean for columns (it means "for each line")

	PL1	PL2	PL3	PL4
PL1	0	-0.5	0.5	0

5) Find the maximum absolute difference (first value). The PL2 has the max "shift" from other lines.

6) Shift PL2 using "maximum difference".

Num(2) >> add (-0.5) to Z for PL2-row

	PL1	PL2	PL3	PL4
PL1	NaN	NaN	2	2
PL2	NaN	NaN	1.5	1.5
PL3	2	1	NaN	NaN
PL4	2	1	NaN	NaN

Num(4) >> add (-0.5) to Z for PL2-column

	PL1	PL2	PL3	PL4
PL1	NaN	NaN	2	2
PL2	NaN	NaN	1	1
PL3	2	1.5	NaN	NaN
PL4	2	1.5	NaN	NaN

7) Make iterations for steps 3-to-6 to "small difference" or to "the number of cycles" true flag.

The final "difference matrix" Num(2) – Num(4).

	PL1	PL2	PL3	PL4
PL1	NaN	NaN	-0.25	0.25
PL2	NaN	NaN	0.25	-0.25
PL3	0.25	-0.25	NaN	NaN
PL4	-0.25	0.25	NaN	NaN

The final Num(2) and Num(4)

	PL1	PL2	PL3	PL4
PL1	NaN	NaN	2	2
PL2	NaN	NaN	1.5	1.5
PL3	2.25	1.25	NaN	NaN
PL4	1.75	2.75	NaN	NaN

	PL1	PL2	PL3	PL4
PL1	NaN	NaN	2.25	1.75
PL2	NaN	NaN	1.25	1.75
PL3	2	1.5	NaN	NaN
PL4	2	1.5	NaN	NaN

8) Calculate statistics for "difference matrix" (MAD=0.25) and shift for each PL (Num4_final-Num4)

	PL1	PL2	PL3	PL4
PL1	0	-0.5	0.25	-0.25

4. Picking and graphics

4.1 Manual spikes piking for polyline

function p=gMapPickHandleNan(X,Y,f)

Set to Nan points on curve using manual piking.

Parameters:

X,Y – rows with curve's coordinates;

f – figure number or pointer to figure;

p – pointer to curve;

a=get(p,'Ydata') – get Y-coordinate with NaN;

a=get(s,'UserData') – get logical mask for ~NaN value.

Function Example

```
>> s=gMapPickHandleNan(HGps.GpsLat,HGps.GpsLon,100);a=get(s,'Ydata');a=get(s,'UserData');
```

There are two picking tools (***Figure 4.1***):

1) rectangle (first button at added panel) – set to nan all points in selected rectangle;

2) curve_part (second button at added panel) – set to nan all points in selected curve's part.

Point at curve set using minimal distance from mouse-click, distance calculates for current axis-scale (axis not equal).

Buttons:

LeftMouseButton – first selection element (first part of rectangle or first point at curve);

RightMouseButton – second selection element (second part of rectangle or second point at curve);

MiddleMouseButton – set to NaN points in selected area (to nan set Y-coordinate value);

z – undo;

x – redo;

q – Exit.

DataTips show: X,Y – coordinate; point number; curve ID.

There can create several independent "nan-pick-button" at one figure for different curves.

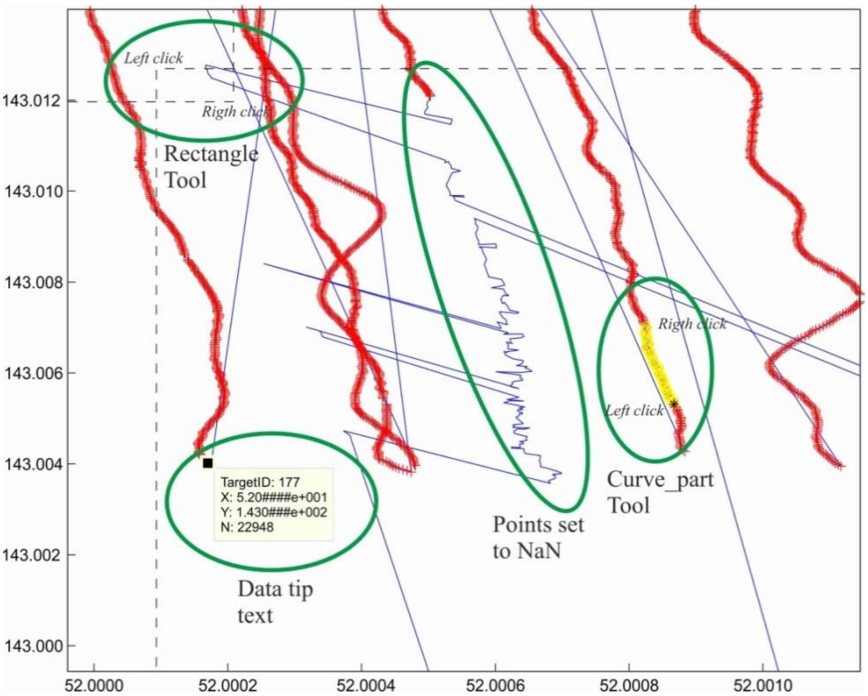


Figure 4.1 gMapPickHandleNan tools

4.2 Set Tick Labels format

function gMapTickLabel(fig,key,fntSize)

Remove exponent, set format and font for figure's Tick Labels.

Parameters:

fig – figure number or handle;

skey – format for label: '$%,.2f', '%g\\circ', '%g%%', '%,g', '%,4.4g','%+4.4g','%04.4g','%-4.4g','%#4.4g' (https://www.mathworks.com/help/matlab/ref/matlab.graphics.axis.decorator.numericruler-properties.html)

skey can be separate for X and Y axis using cells {'%.1f','%.4f'}; if empty, than format is not changed (font size only).

fntSize – font size. Function Example:

```
>> gMapTickLabel(7,'%.2f',12);
```

4.3 Set Tips data

function output_txt=gMapTipsLabel (~,event_obj,varargin)

Create tips with current position and additional data.

Parameters:

obj – currently not used (empty);

event_obj – handle to event object;

varargin – additional data for tips' text creation (row numbers with length equal to points number);

output_txt – data cursor text string (string or cell array of strings).

Function Example:

```
>> figure(100);dcm_obj=datacursormode(100);set(dcm_obj,'UpdateFcn',{@gMapTipsLabel});
```

Citation